ISSN (print) 0093-4666 © 2010. Mycotaxon, Ltd. ISSN (online) 2154-8889

MYCOTAXON

DOI: 10.5248/114.99

Volume 114, pp. 99–107 *October–December 2010*

Morphological studies of *Hyphoderma cremeoalbum* and *Radulomyces roseolus*

Karen K. Nakasone

knakasone@fs.fed.us
Northern Research Station, U.S. Forest Service
One Gifford Pinchot Drive, Madison, WI 53726–2398, USA

Abstract — Type studies reveal that *Radulomyces roseolus* is conspecific with *Hyphoderma cremeoalbum* (*Basidiomycota*, *Polyporales*). Embedded, fusoid cystidia and haplohyphidia are critical diagnostic features of *H. cremeoalbum*. Known from Europe, United States, Argentina, and New Zealand, its preferred substrate is decorticated and decayed gymnospermous wood, especially *Picea*, but the species also occurs on woody angiosperms.

Key words — *Corticiaceae* sensu lato, *Corticium cremeoalbum*, phlebioid clade, taxonomy

Introduction

Hyphoderma Wallr. is a genus of ubiquitous corticioid homobasidiomycetes with about 100 species reported worldwide (Parmasto et al. 2004). An old but vaguely circumscribed genus, recent molecular studies demonstrate that *Hyphoderma* is polyphyletic with most species distributed in two clades — the *Hymenochaetales* and the *Polyporales* (Langer 2001; Larsson 2007; Larsson et al. 2004). Larsson (2007) resurrected the genus *Peniophorella* P. Karst. to accommodate most of the *Hyphoderma* species in the *Hymenochaetales*. *Hyphoderma* sensu stricto, in the *Polyporales*, consists of species with resupinate, effuse basidiomes, monomitic hyphal systems of clamped hyphae, often with leptocystidia or other types of cystidia, suburniform to subcylindrical basidia with four sterigmata, and thin-walled, smooth basidiospores that range from cylindrical to subglobose (Larsson 2007).

Radulomyces roseolus (Parmasto 1968), known only from the type from Georgia in eastern Europe, is morphologically similar to *Hyphoderma cremeoalbum*. In this study, type specimens of *Corticium cremeoalbum* and *R. roseolus* were examined and determined to be conspecific. The types are

described, illustrated, and compared, and a description of *H. cremeoalbum* is provided.

Materials and methods

Thin, freehand sections or scrapings from the basidiomes were mounted in a Melzer's reagent (Kirk et al. 2008) or 1% (weight/volume) aqueous phloxine and 1% (w/v) aqueous potassium hydroxide. Drawings were made with a camera lucida attachment on an Olympus BH2 compound microscope. Q values were obtained from dividing average basidiospore length by width (Kirk et al. 2008). Basidiospores are often scarce in specimens, thus Q values based on less than 30 basidiospores are approximate and indicated with an asterisk (*). Color names are from Kornerup & Wanscher (1978), and herbarium designations follow that of Index Herbariorum (Thiers, continuously updated).

The term "haplohyphidia" refers to the simple, unbranched, unmodified hyphal ends developed in the hymenium (Donk 1964). Although little used, this term is useful to distinguish among the various types of hyphidia produced in corticioid fungi.

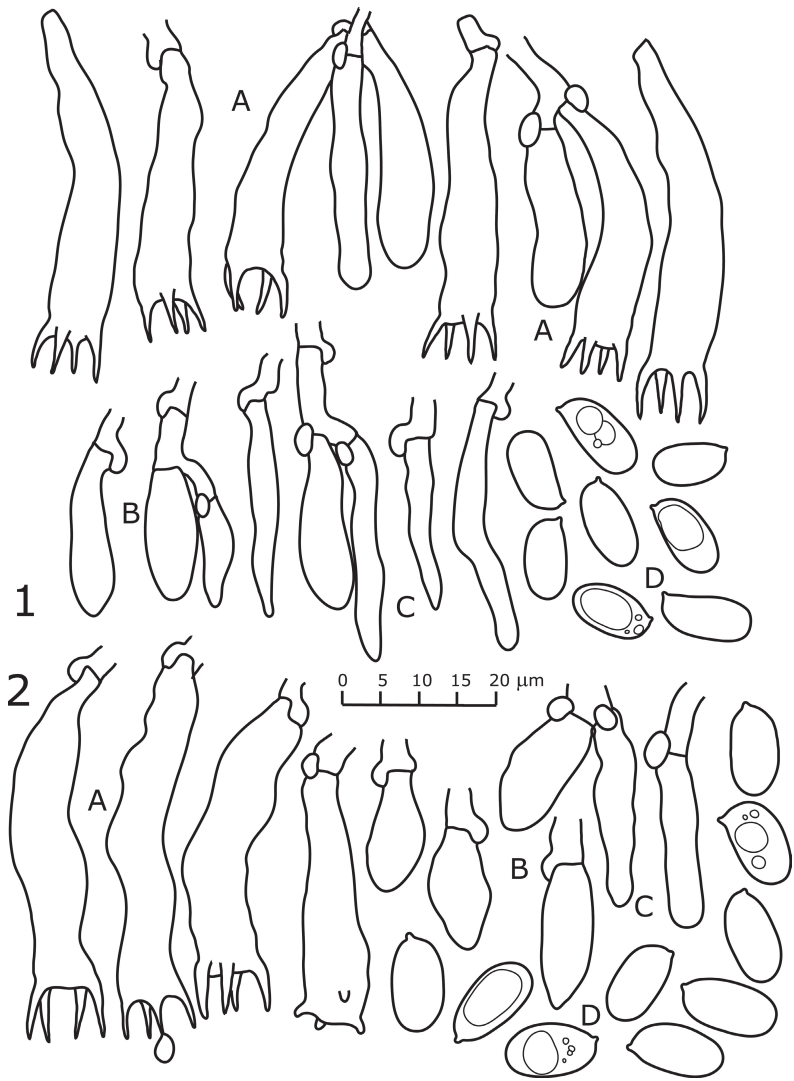
Taxonomy

Type species descriptions

Radulomyces roseolus Parmasto, Consp. syst. cortic. p. 222. 1968. Fig. 1

Holotype: **RPSS.** Georgica: Hulo in piceeto, alt. 1300 m., ad caudicem Piceae orientalis prolapsum, 7 October 1963, E. Parmasto (*TAA 16822*).

Basidiome resupinate, effuse, colonies irregular, up to 8 × 6 mm, thin, up to 100 µm thick, subceraceous to submembranous. Hymenial surface smooth, pruinose, yellowish white (4A2), orange white [5A(2–3)], or greyish orange (5B3). Margin thinning out, pruinose, concolorous with hymenial surface or white to off-white. Hyphal system monomitic with clamped generative hyphae. Subiculum indistinct, up to 30 µm thick; subicular hyphae 3.5–5.5 µm diam, clamped, moderately branched, walls thin, hyaline, smooth. Subhymenium up to 30 µm thick, a dense, compact tissue; subhymenial hyphae similar to subicular hyphae. Hymenium up to 50 µm thick, a dense palisade of haplohyphidia, cystidia, and basidia. Haplohyphidia embedded, numerous, cylindrical, tapering slightly toward apex, (13–)23–40 × 3–4 µm, clamped at base, simple, unbranched, walls thin, hyaline, smooth. Cystidia embedded, inconspicuous, clavate to broadly fusiform with an obtuse apex, 17–22 × 5.5–7.5 µm, clamped at base, walls thin, hyaline, smooth. Basidia clavate, 28–45(–55) × 6.5–8(–9) µm, clamped at base, walls thin, hyaline, smooth; 4-sterigmate. Basidiospores cylindrical, (9.3–)10–12(–13) × 5–6 µm, average of 16 spores 10.9 ± 1.0 × 5.6 ± 0.3 µm, Q = 1.9*, with oil-like globules, walls thin, hyaline, smooth, acyanophilous, not reacting in Melzer's reagent.



Figs. 1–2. Line drawings of microscopic elements.
1. *Radulomyces roseolus* holotype (TAA16822). **2**. *Corticium cremeoalbum* holotype (Höhnel 684).
A, basidia; B, cystidia; C. haplohyphidia; D, basidiospores.

Comments — In the type, the well-decayed wood is broken up into fragments that support even smaller fragments of the basidiome. On one fragment is a brown-colored basidiome, which represents a *Tomentella* species, probably *T. sublilacina* (Ellis & Holw.) Wakef. Observations of the type correlate closely to the protologue except for minor differences. For example, the basidiospores observed were slightly smaller than originally cited —10–14(–15) × 5.5–6.5 (–7) µm — and yellow resinous materials in the hymenium and subiculum described in the protologue were not observed. In addition, the hymenium color is described as "incarnato-roseum, nonnumquam cremeo coloratum", but pink-colored hymenia were not observed in the type material, possibly because the pink color of fresh specimens fades to cream in dried material. Although the presence of haplohyphidia probably led to the placement of this taxon in *Radulomyces,* most *Radulomyces* species have thicker, robust basidiomes with distinct tubercules or spines. In a note included in the type envelope, B. Duhem noted a similarity of *R. roseolus* with *H. cremeoalbum* and suggested that they were conspecific.

Corticium cremeoalbum Höhn. & Litsch., Wiesner-Festschrift p. 63. 1908. Fig. 2

Holotype: (**Austria**) Wiener Wald, am Sattelberg bei Preßbaum, auf morschem Nadelholz, 2 October 1901, Höhnel no. *684* (*FH 00258439*).

Basidiome resupinate, widely effuse, thin, up to 75 µm thick, subceraceous to membranous. Hymenial surface discontinuous, smooth to slightly uneven with barely differentiated warts, pruinose to porulose, yellowish white (4A2) to greyish yellow (4B3). Margin indistinct, thinning out, pruinose, concolorous with hymenial surface. Hyphal system monomitic with clamped generative hyphae. Subiculum up to 40 µm thick, composed of partially agglutinated hyphae arranged perpendicular to substrate; subicular hyphae 5–7 µm diam, clamped, moderately branched, walls thin, hyaline, smooth. Subhymenium indistinct. Hymenium up to 40 µm thick, a dense palisade of haplohyphidia, cystidia, and basidia. Haplohyphidia embedded, scattered, cylindrical or tapering slightly toward apex, 23–25 × 5 µm, clamped at base, simple, unbranched, walls thin, hyaline, smooth. Cystidia embedded, scattered, broadly fusoid to ovoid, 16–21 × 6–8.5 µm, clamped at base, walls thin, hyaline, smooth. Basidia more or less cylindrical with slight, irregular constrictions or clavate, 30–55 × (6.5–)8–10 µm, clamped at base, walls thin, hyaline, smooth; 4-sterigmate. Basidiospores broadly cylindrical (9.5–)10–12(–13) × 6–7 µm, average of 20 spores 11.5 ± 0.8 × 6.3 ± 0.3 µm, Q = 1.8*, with oil-like globules, walls thin, hyaline, smooth, acyanophilous, not reacting in Melzer's reagent.

Comments — The type of *C. cremeoalbum* is in good condition. The protologue, however, does not mention the presence of haplohyphidia or fusoid cystidia. Basidiospore length, given in the protologue as 10–14 × 5.5–6.5 µm,

is slightly longer than observed. Except for these differences, the type does not deviate significantly from the protologue. Litschauer's specimen, mislabeled as holotype in Eriksson & Ryvarden (1975, p. 464), differs from the holotype at FH in lacking cystidia. Haplohyphidia are illustrated but interpreted as immature basidia.

No significant discrepancies were observed between the types of *R. roseolus* and *C. cremeoalbum*. In fact, the morphological similarities are overwhelming, and one can only conclude that these taxa are conspecific. An additional 25 herbarium specimens of *H. cremeoalbum* were studied to provide the expanded and inclusive description below.

Species description

Hyphoderma cremeoalbum (Höhn. & Litsch.) Jülich, Persoonia 8(1): 80. 1974.

Fig. 3

≡ *Corticium cremeoalbum* Höhn. & Litsch., Wiesner-Festschrift p. 63. 1908.
= *Radulomyces roseolus* Parmasto, Consp. syst. cortic. p. 222. 1968.
≡ *Cerocorticium roseolum* (Parmasto) Jülich & Stalpers, Verh. Kon. Ned. Akad. Wetensch., Afd. Natuurk. II 74: 72. 1980.

Basidiome resupinate, widely effuse, thin, up to 200 µm thick, subceraceous to membranous. Hymenial surface smooth to slightly uneven, sometimes verruculose, up to 3 warts per mm, sometimes discontinuous, porulose to pruinose or subfelty, yellowish white [(2–4)A2], dull yellow [3B3], pale yellow [4A2], orange white [5A(2–3)], yellowish grey [4B2], greyish yellow [(4–5)B3], pale orange [5A3], or greyish orange [(5–6)B3], warts occasionally discolored brown. Margin thinning out, indistinct, pruinose. Hyphal system monomitic with nodose-septate generative hyphae. Subiculum up to 150 µm thick, a moderately dense tissue of partially agglutinated ascending hyphae and coarse, hyaline crystal clusters; subicular hyphae 3.5–7 µm diam, occasionally inflated up to 11 µm diam at nodes, clamped, moderately to frequently branched, walls thin, hyaline, smooth. Subhymenium indistinct, up to 30 µm thick, a moderately dense tissue of partially agglutinated, short-celled hyphae; subhymenial hyphae 4–8 µm diam, clamped, frequently branched, walls thin, hyaline, smooth. Hymenium up to 50 µm thick, a dense palisade of haplohyphidia, cystidia and basidia. Haplohyphidia scattered to numerous, cylindrical or tapering slightly toward apex, (16–)22–35(–48) × 3–6 µm, clamped at base, simple, rarely branched, walls thin, hyaline, smooth. Cystidia enclosed, scattered, broadly fusoid to ovoid, rarely globose, 14–28 × 6–14 µm, clamped at base, walls thin, hyaline, smooth. Basidia clavate, suburniform to subcylindrical with slight, irregular constrictions, (23–)30–55 × 6.5–10.5 µm, clamped at base, walls thin, hyaline, smooth; 4-sterigmate. Basidiospores broadly cylindrical to cylindrical, (9.5–)10–14(–17) × 5–7(–8) µm, average size 11.6–13.4 × 5.5–6.6

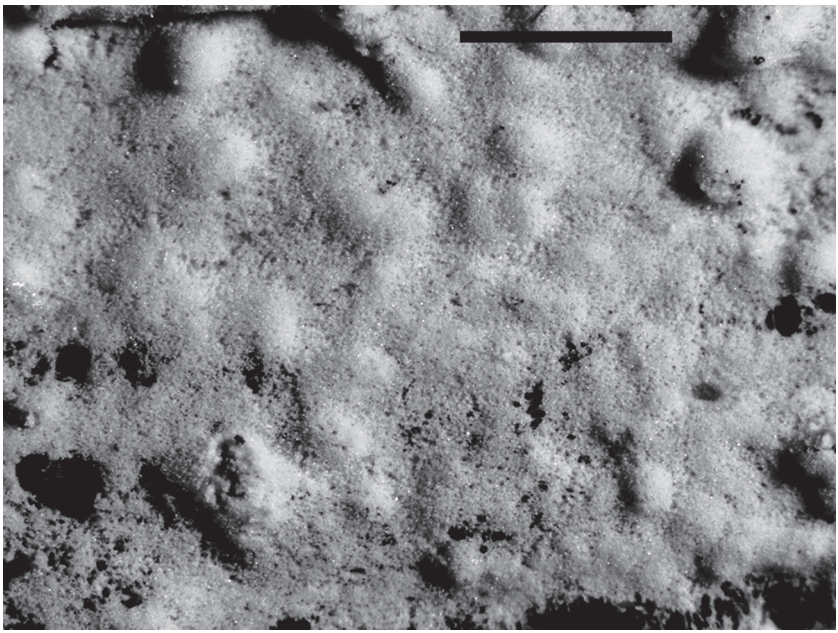


Fig. 3. Verruculose basidiome surface of *Hyphoderma cremeoalbum* (KHL4100). Bar = 1 mm.

µm, Q = 2*–2.1, often containing oil-like globules, occasionally germinating, walls thin, hyaline, smooth, acyanophilous, not reacting in Melzer's reagent.

Habitat — Well-decayed wood and bark of gymnosperms, especially *Picea*, and angiosperms.

Distribution — Argentina, Austria, Finland (Kotiranta & Larsson 1989), France, Georgia, Germany (Grosse-Brauckmann 1990), Italy, New Zealand, Norway, Romania, Spain (Hjortstam et al. 1981, Tellería 1990), Sweden, Switzerland, Turkey, United States (Washington).

Holotype specimens examined — *Radulomyces roseolus* and *Corticium cremeoalbum* – see above.

Representative specimens examined — **Argentina.** Departamento Chubut: Languiñeo, Lago Guacho, on (well-decayed) *Nothofagus pumilio* (Poepp. & Endl.) Krasser, 18 April 1997, A Greslebin *807*; Tierra del Fuego, Departamento Ushuaia: Estanica El Valdéz, on (well-decayed) N. *pumilio*, 04–05 March 1996, A. Greslebin *225* and *354*. **Austria.** Salzburg, Hohe Tauern, Taxenbach, 1200 m s.m., on *Picea abies* (L.) H. Karst., 13 July 1997, W. Dämon, *RP96/257E* (Herb. Dämon); Kalkalpen, Golling, 1500–1600 m s.m., on *P. abies,* 10 August 1997, W. Dämon, *RP96/257G* (Herb. Dämon). **France.** Forêt de Fontainebleau, Gorge aux Loups, parcella 527, on decayed trunk of *Fagus sylvatica* L., 31 October 2006, E. Martini *9490* (Herb. Martini). **Italy.** Riserva di

Sesso Fratino (FC), 720 m, on *Abies alba* Mill., 10 October 1991, A. Bernicchia *5651* (HUBO). **New Zealand.** Bay of Plenty, Te Waiiti, on decaying wood (bark), 17 May 2006, B.C. Paulus and P.R. Johnston, *BCP3640*, *PDD89111* (PDD). **Norway.** Hedmark, Löten, Gitvola, on well-decayed, decorticated *Picea* log, 11 September 1986, K.-H. Larsson *6508*, *GB1773*, *GB0052597* (GB). **Romania.** Neamt, Monastry Sihastria, in *Fagus* forest, on decayed, decorticate *Fagus* log, 17 October 1985, N. Hallenberg *9216*, *GB1549*, *GB0052600* (GB). **Sweden.** Dalarna: Särna Parish, Fulufjället at Göjån, close to Falun, on (decorticate, decayed) *Picea abies* 10 September 2004, K.-H. Larsson *12404*, *GB0052601* (GB); Lycksele Lappmark: Sorsele Parish, Grannäs, Västra Lairobäcken, on timber at abandoned saw mill, 28 August 1983, K.-H. Larsson *4110*, *GB885*, *GB0052598* (GB); Lycksele Lappmark Kirjesålandet, Vittertj. in alpine *Picea-Betula* forest, on stem of *Betula,* 16 August 1982, K.-H. Larsson *2677*, *GB456*, *GB0052766* (GB). **Switzerland.** (Tessin) Malvaglia, on decayed coniferous wood, 19 September 1987, E. Martini *1206* (herb. Martini); (Tessin) Meride, Bagno, on decayed, decorticated *Tilia cordata* Mill., 2 June 2007, E. Martini *9834* (Herb. Martini). **Turkey.** NE Anatolia, Trabzon area, Sumela Monastry, on (decorticate, decayed) *Picea* wood, 2 October 1989, N. Hallenberg *11538*, *GB2270*, *GB0052599* (GB). **United States.** Washington: Olympic National Forest, Quinault Research National Area, Plot 10-1-A-5, on decayed *Picea sitchensis* (Bong.) Carrière log, 15 October 1992, H.H. Burdsall, Jr. and M. Banik, *HHB14826* (CFMR); Plot 10-1-A-13, on bark of *P. sitchensis,* 15 October 1992, H.H. Burdsall, Jr., *HHB14834* (CFMR).

Comments — *Hyphoderma cremeoalbum* is characterized by thin, smooth to verruculose basidiomes, cylindrical basidiospores, haplohyphidia, and enclosed fusoid cystidia. Because the cystidia are enclosed in the hymenium and haplocystidia are barely differentiated, they are easily overlooked. The description and illustrations of *H. cremeoalbum* in Eriksson & Ryvarden (1975) does not include information on cystidia, and haplohyphidia are interpreted as developing basidia. Hallenberg (1991) found that haploid isolates of *H. cremeoalbum* from Norway, Sweden, Turkey and Romania were partially or fully compatible. Although most frequently collected in Europe, *H. cremeoalbum* is widely distributed as evidence by collections from northwestern United States, southern Argentina (Greslebin 2002, Greslebin & Rajchenberg 2003), and New Zealand.

There are three species of *Hyphoderma* morphologically similar to *H. cremeoalbum.* In *Hyphoderma nemorale* K.H. Larss. and *H. incrustatum* K.H. Larss., the cylindrical basidiospores are slightly narrower (Q = 2.55 and 2.57, respectively) than in *H. cremeoalbum*. Additionally, they produce large, cylindrical, embedded cystidia as well as capitate or subcapitate hymenial cystidia (Larsson 1998). Like *H. cremeoalbum*, *H. sibiricum* (Parmasto) J. Erikss. & Å. Strid has haplohyphidia but significantly smaller basidia, 25–35(–40) × 5–7 µm, and basidiospores, 7–8(–9) × (4–)4.5–5 µm (Eriksson & Ryvarden 1975; Ginns 1982).

Hyphoderma cremeoalbum was reported on *Quercus ilex* L. from Sardinia, AB6632 (Bernicchia et al. 2008); however, this specimen appears to be

H. malenconii (Manjón & G. Moreno) Manjón et al. Jung (1987) cited two specimens of *H. cremeoalbum* from southeastern United States on *Abies fraseri* (Pursh) Poir. but neither is correctly identified. TENN 46846 is probably *H. pilisetum* (Burt) Liberta. In TENN 46975, the basidiospores are narrower than typical for *H. cremeoalbum*; this specimen appears to represent *H. occidentale* (D.P. Rogers) Boidin & Gilles. From Arizona, Gilbertson & Bigelow (1998) reported *H. cremeoalbum,* RLG 16887, on *Pseudotsuga menziesii* (Mirb.) Franco, but this specimen is *Peniophorella praetermissa* (P. Karst.) K.H. Larss. Gilbertson et al. (2002) listed *H. cremeoalbum* from Moloka`i, Hawaii, on *Eucalyptus robusta* Sm. The specimen, RLG 22966, has numerous fusoid gloeocystidia and appears to be an undescribed species with close affiliation to *P. praetermissa*. The report of *H. cremeoalbum* from the Leningrad region on *Populus tremula* L. should be reconfirmed because cystidia and haplohyphidia were not observed (Zmitrovich & Spirin 2002). Similarly, reports of *H. cremeoalbum* from Italy on *Castanea sativa* Mill. (Mayrhofer et al. 2001) and from China (Maekawa & Zang 1995, Maekawa et al. 2002), need to be confirmed.

Acknowledgements

The curators of the following herbaria arranged specimen loans: ARIZ, BPI, FH, GB, HUBO, PDD, TAA, TENN. Elia Martini of Bignasco, Switzerland, and Dr. Wolfgang Dämon of Salzburg, Austria, loaned specimens from their private herbaria. Drs. Harold H. Burdsall, Jr. and Wolfgang Dämon reviewed an earlier draft of this manuscript and provided valuable comments and corrections.

Literature cited

Bernicchia A, Arras L, Piga A, Ryvarden L. 2008. Biodiversity of Sardinian aphyllophoraceous fungi. Synopsis Fungorum 25: 53–124.

Donk MA. 1964. A conspectus of the families of *Aphyllophorales*. Persoonia 3: 199–324.

Eriksson J, Ryvarden L. 1975. The *Corticiaceae* of North Europe. Volume 3. *Coronicium – Hyphoderma*. Fungiflora: Oslo (Norway).

Gilbertson RL, Bigelow DM. 1998. Annotated check list of wood-rotting basidiomycetes of the sky islands of southeastern Arizona. Journal of the Arizona-Nevada Academy of Science 31: 13–36.

Gilbertson RL, Bigelow DM, Hemmes DE, Desjardin DE. 2002. Annotated check list of wood-rotting basidiomycetes of Hawai`i. Mycotaxon 8: 215–239.

Ginns J. 1982. Hyphoderma sibiricum. Fungi Canadenses No. 230. Agriculture Canada: Ottawa (Canada).

Greslebin AG. 2002. Flora Criptogámica de Tierra del Fuego. *Fungi, Basidiomycota, Aphyllophorales: Coniophoraceae, Corticiaceae, Gomphaceae, Hymenochaetaceae, Lachnocladiaceae, Stereaceae, Thelephoraceae. Tulasnellales: Tulasnellaceae*. Consejo National de Investigaciones Científicas y Técnicas de la República Argentina (CONICET): Buenos Aires (Argentina). 212 pp.

Greslebin AG, Rajchenberg M. 2003. Diversity of *Corticiaceae* sens. lat. in Patagonia, Southern Argentina. New Zealand Journal of Botany 41: 437–446.

Grosse-Brauckmann H. 1990. Corticioide Basidiomyceten in der Bundesrepublik Deutschland. Funde 1960–1989. Zeitschrift für Mykologie 56(1): 95–130.

Hallenberg N. 1991. Pairing tests with species of *Aphyllophorales* (*Basidiomycetes*) from two phytogeographically isolated areas. Mycotaxon 42: 355–386.

Hjortstam K, Tellería MT, Ryvarden L, Calonge FD. 1991. Notes on the *Aphyllophorales* of Spain II. Nova Hedwigia 34: 525–538.

Jung HS. 1987. Wood-rotting *Aphyllophorales* of the southern Appalachian spruce-fir forest. J. Cramer: Berlin (Germany). 260 pp.

Kirk PM, Cannon PF, Minter DW, Stalpers JA. 2008. Ainsworth & Bisby's Dictionary of the fungi. 10th ed. CAB International: Wallingford (United Kingdom). 771 pp.

Kotiranta H, Larsson K-H. 1989. New or little collected corticolous fungi from Finland (*Aphyllophorales, Basidiomycetes*). Windahlia 18: 1–14.

Kornerup A, Wanscher JH. 1978. Methuen handbook of colour. Eyre Methuen: London (United Kingdom). 252 pp.

Langer E. 2001. Phylogeny of non-gilled and gilled basidiomycetes – DNA sequence inference, ultrastructure and comparative morphology. Habilitationsschrift, Tübingen University, Tübingen (Germany). 54 pp.

Larsson K-H. 1998. Two new species in *Hyphoderma*. Nordic Journal of Botany 18: 121–127.

Larsson K-H. 2007. Molecular phylogeny of *Hyphoderma* and the reinstatement of *Peniophorella*. Mycological Research 111: 186–195. doi:10.1016/j.mycres.2007.10.001

Larsson K-H, Larsson E, Kõljalg U. 2004. High phylogenetic diversity among corticioid homobasidiomycetes. Mycological Research 108: 983–1002. doi: 10.1017/S0953756204000851

Maekawa N, Zang M. 1995. Corticiaceous fungi (*Aphyllophorales, Basidiomycotina*) collected in Yunnan, China. Bulletin of the National Science Museum, Tokyo 21: 87–84.

Maekawa N, Yang ZL, Zang M. 2002. Corticioid fungi (*Basidiomycetes*) collected in Sichuan Province, China. Mycotaxon 83: 81–95.

Mayrhofer S, Peintner U, Bernicchia A. 2001. Aphyllophoraceous fungi on *Castanea sativa* in Italy. Mycotaxon 80: 267–279.

Parmasto E. 1968. Conspectus systematis corticiacearum. Academiae Scientiarum R.P.S.S. Estonicae: Tartu (Estonia). 261 pp.

Parmasto E, Nilsson RH, Larsson K-H. 2004. Cortbase version 2. Extensive updates of a nomenclatural database for corticioid fungi (*Hymenomycetes*). Phyloinformatics 5: 1–7.

Telleria MT. 1990. Annotated list of the *Corticiaceae,* sensu lato (*Aphyllophorales, Basidiomycotina*), for peninsular Spain and Balearic Islands. Bibliotheca Mycologica 135: 1–152.

Thiers B. [continuously updated]. Index Herbariorum. A global directory of public herbaria and associated staff. New York Botanical Garden's Virtual Herbarium. http://sweetgum.nybg.org/ih/

Zmitrovich IV, Spirin WA. 2002. Notes on the aphyllophoroid fungi of the Leningrad region I. Novosti Sistematiki Nizshikh Rastenii 36: 36–44.